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10/713,774	11/13/2003	Yushan Yan	02307W-142300	8752

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EXAMINER

LEWIS, BEN

ART UNIT	PAPER NUMBER
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1745

DATE MAILED: 07/25/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 10/713,774	Applicant(s) YAN ET AL.	
	Examiner Ben Lewis	Art Unit 1745	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-8,12,13,15,16 and 18-20 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-8,12,13,15,16 and 18-20 is/are rejected.
- 7) ☐ Claim(s) ____ is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 13 November 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. ____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____. |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date <u>4/24/06</u> . | 6) <input type="checkbox"/> Other: ____. |

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claim 1 is rejected under 35 U.S.C. 103(a) as being unpatentable over Frank et al (DE 101 18 651 A1). See corresponding U.S. Publication - Frank et al (U.S. Pub. No. 2004/0170884 A1) and Dodelet et al (U.S. Pub. No. 2003/0111334 A1) and further in view of Yates et al. (U.S. Patent No. 6,224,991 B1).

With respect to claim 1, Frank et al disclose a fuel cell wherein the fuel cell has the following characteristics: the electrodes comprise electrically conductive, regularly disposed micro or nanoscale needle-shaped or tubular-shaped electrode elements affixed on a gas-permeable carrier substrate and coated with a catalyst; the electrode elements are fully or partially surrounded on the outside by the material of the electrolytes (See Abstract). Frank et al further teach that specifically, there are two inventive variants of the electrode structure: Electrically conductive, needle-shaped electrode elements (hereinafter also referred to as "nanowhiskers") on a carrier substrate, and electrically conductive, tube-shaped electrode elements (hereinafter also referred to as "nanotubes") on a carrier substrate. These electrode elements can also

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be porous. The electrode elements are coated with a catalyst, and completely or partially surrounded on the outside by the electrolyte material (for example, a polyelectrolyte membrane) (Paragraph 0011 – 0014). Frank et al does not specifically mention growing carbon nanotubes on a carbon substrate using a chemical vapor deposition process. However, Dodelet et al teach a process for preparing carbon nanotubes wherein an object of the present invention is to provide a new carbon vapor deposition method which is capable of producing carbon nanotubes in the absence of amorphous carbon at low heating power (Paragraph 0005). The carbon paper carrying the catalyst is placed between two graphite electrodes, mounted in a quartz tube. In order to obtain the carbon nanotubes, a mixture of 90% argon, 5% hydrogen and 5% of a hydrocarbon gas (acetylene or ethylene) is caused to flow over the paper for 15 minutes (Paragraph 0028). FIG. 2 illustrates a typical area of nanotubes produced on the carbon paper (Paragraph 0030).

Therefore it would have been obvious to one of ordinary skill in the art to use the method of growing of carbon nanotubes on a carbon substrate using a CVD process of Dodelet et al in the fuel cell of Frank et al because Dodelet et al teach that an object of the present invention is to provide a new carbon vapor deposition method which is capable of producing carbon nanotubes in the absence of amorphous carbon at low heating power (Paragraph 0005).

Frank et al and Dodelet et al do not specifically teach wherein said depositing cobalt comprises electrodeposition on one side of the carbon substrate by three dc method in a 5 wt. % CoSO_4 and 2wt. % H_3BO_3 aqueous solution at 20°C . However,

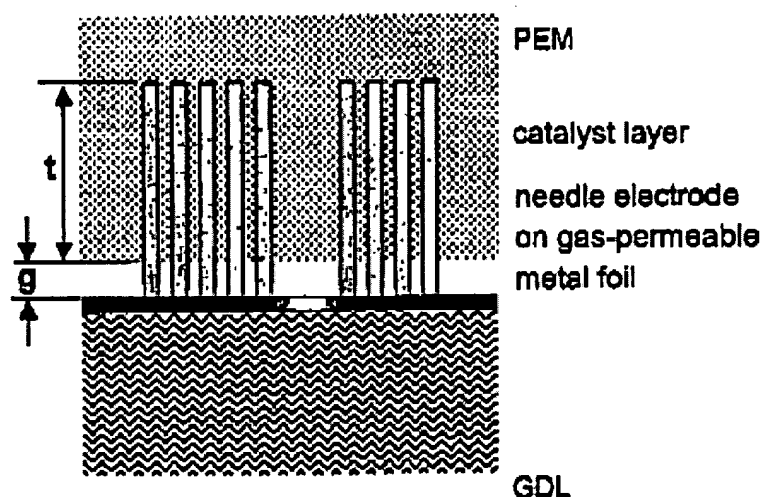
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Yates et al. teach a process for electrodeposition of barrier layer wherein the electrolyte in the barrier layer treater tanks is a boric acid/cobalt, e.g., cobalt sulfate (CoSo.sub.4) aqueous solution containing a relatively low concentration of cobalt ions, e.g., less than about 40, and preferably in the range of from about 4 to about 30, grams per liter of electrolyte (Col 7 lines 35-45). Therefore it would have been obvious to use the electrolyte composition of Yates et al. to electrodeposit cobalt in the nanotubes of Frank et al and Dodelet et al because Yates et al teach that H_3BO_3 is used in the electrolyte as a buffer that stabilizes the pH at the electrolyte/cathode (copper foil) interface (Col 8 lines 14-16). When using the electrolyte described above, the plating parameters shown in the following table have been found effective in electrodepositing on the surface of the treatment a continuous layer of cobalt which is plated in a substantially uniform thickness (Col 9 lines 25-35).

With respect to claim 2, Frank et al teach that the gas diffusion is promoted by the relatively open needle structure, which is directly connected to the macroscopic GDLs via gas channel g (Paragraph 0027) (See Fig. 3). Frank et al further teach that specifically, there are two inventive variants of the electrode structure: Electrically conductive, needle-shaped electrode elements (hereinafter also referred to as "nanowhiskers") on a carrier substrate, and electrically conductive, tube-shaped electrode elements (hereinafter also referred to as "nanotubes") on a carrier substrate. These electrode elements can also be porous. The electrode elements are coated with

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a catalyst, and completely or partially surrounded on the outside by the electrolyte material (for example, a polyelectrolyte membrane) (Paragraph 0011 – 0014).

Fig. 3

With respect to claim 15, Frank et al teach that porous, nanoscale tubes (for example, of graphite) that are coated on the outside with platinum are regularly arranged on a carrier membrane made, for example, of ceramics (Paragraph 0030).

With respect to claim 16, Frank et al teach that Subsequently, particles for forming the needle- or tube-shaped electrode elements are embedded into the pores, it

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being possible to use different methods, depending on the material and type of construction. Suitable methods for depositing metallic particles of nickel, cobalt, chromium, manganese, copper, zinc, tin, and of noble metals are, in particular, electrochemical and electroless plating methods, while pyrolytic methods are used for depositing graphite-like layers or other metals. Examples here include the decomposition of acetylene or other hydrocarbons or of metal-organic compounds in the gas phase under the action of temperature, catalysts and/or plasma discharges. For example, the oxides structure (oxidation treated) can also be impregnated with a wetting solution (incipient-wetness) of suitable monomers (acrylonitrile, emulsifier, initiator), and subsequently polymerized. The polymer (polyacrylonitrile) is pyrolyzed at elevated temperatures, and converted into graphite-like tubes or fibers. There are many known variants of this basic method that can, in principle, be used within the spirit of the present invention. However, the use of nanoscale electrode structures of graphite is regarded as particularly attractive because good electric conductivity, high chemical stability, and low cost of the starting materials can be made compatible in this manner (Paragraph 0049).

With respect to claim 19, Frank et al teach that the electrode elements are coated with a catalyst, and completely or partially surrounded on the outside by the electrolyte material (for example, a polyelectrolyte membrane) (Paragraph 0011 – 0014). Nafion is a polyelectrolyte membrane which is also a perfluorosulfonate ionomer.

With respect to claim 20, Frank et al teach that the inventive fuel cell has the following characteristics: the electrodes comprise electrically conductive, regularly disposed micro or nanoscale needle-shaped or tubular-shaped electrode elements affixed on a gas-permeable carrier substrate and coated with a catalyst; the electrode elements are fully or partially surrounded on the outside by the material of the electrolytes; the catalytic reaction zones in the electrode elements are connected to the means for gas distribution by the gas-permeable carrier substrate; the electrode elements are connected to one another and to the electric contacting of the individual cells in an electrically conductive manner (See Abstract).

3. Claims 3 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Frank et al (U.S. Pub. No. 2004/0170884 A1), Dodelet et al (U.S. Pub. No. 2003/0111334 A1) and Yates et al. (U.S. Patent No. 6,224,991 B1) as applied to claims 1,2,15-16,19 and 20 above and further in view of Smalley et al (U.S. Pub. No. 2002/0159943 A1).

With respect to claims 3 and 4, Frank et al disclose a fuel cell in paragraph 2 above. Frank et al is silent to the number of walls of the carbon nanotubes used in the fuel cell fabrication and thus, does not specifically disclose whether the carbon nanotubes are single walled or multi walled. However, Smalley et al teach a method of forming an array of single-wall carbon nanotubes and compositions thereof wherein the carbon nanotube that is formed is not always a single-wall carbon nanotube; it may be a

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multi-wall carbon nanotube having two, five, ten or any greater number of walls (concentric carbon nanotubes) (Paragraph 0068). Therefore it would have been obvious to one of ordinary skill in the art to use the single wall and multi walled carbon nanotubes of Smalley et al in the fuel cell of Frank et al because Smalley et al teach that applications of these carbon fibers include all those currently available for graphite fibers and high strength fibers such as membranes for batteries and fuel cells (Paragraph 0196).

4. Claim 5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Frank et al (U.S. Pub. No. 2004/0170884 A1) Dodelet et al (U.S. Pub. No. 2003/0111334 A1) and Yates et al. (U.S. Patent No. 6,224,991 B1) as applied to claims 1,2,15-16,19 and 20 above and further in view of Moskovits et al (U.S. Patent No. 6,129,901).

With respect to claim 5, Frank et al disclose a fuel cell in paragraph 2 above. Frank et al does not specifically mention using anodic porous alumina templates to form an aligned array of carbon nanotubes. However, Moskovits et al teach controlled synthesis and metal filling of aligned carbon nanotubes wherein one aspect of the invention there is provided a process for synthesis of carbon nanotube. The method comprises anodizing an aluminum substrate in an effective bath to produce an alumina template with a plurality of pores each having a pore diameter. The method includes depositing an effective catalyst into the pores and exposing the alumina template with the catalyst containing pores to an effective hydrocarbon gas at an effective

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temperature to grow carbon nanotubes in the pores (Col 2 lines 25-36). The process of synthesizing carbon nanotubes is showed schematically in FIG. 1. Anodic oxidation of an aluminum (99.99%) substrate **10** was carried out. The anodized alumina templates **12** were immersed in acid. Then a mixture of 10% acetylene in nitrogen was introduced into the reactor. Acetylene was decomposed by pyrolysis to form the carbon nanotubes **20** in the template channels (Col 3 lines 15-55). Therefore it would have been obvious to one of ordinary skill in the art to use the nanotube fabrication process of Moskovits et al in the fuel cell fabrication process of Frank et al because Moskovits et al teach that the present method also provides a much more economical method of growing nanotubes since the number of procedural steps is decreased (Col 4 lines 65-67); (Col 5 lines 1-5).

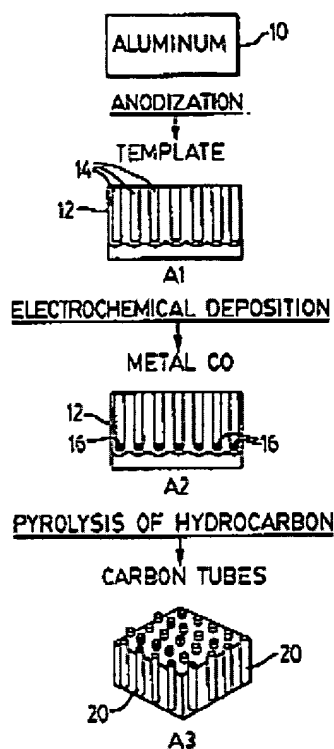


FIG. 1

5. Claim 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Frank et al (U.S. Pub. No. 2004/0170884 A1), Dodelet et al (U.S. Pub. No. 2003/0111334 A1) and Yates et al. (U.S. Patent No. 6,224,991 B1) as applied to claims 1,2,15-16,19 and 20 above and further in view of Moskovits et al (U.S. Patent No. 6,129,901).

With respect to claim 7, Frank et al disclose a fuel cell in paragraph 2 above. Frank et al does not specifically mention where in said forming comprises growing carbon nanotubes on the substrate using chemical vapor deposition process using acetylene in nitrogen as a carbon source. However, Moskovits et al teach controlled synthesis and metal filling of aligned carbon nanotubes wherein the process of

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synthesizing carbon nanotubes is showed schematically in FIG. 1. Anodic oxidation of an aluminum (99.99%) substrate **10** was carried out. The anodized alumina templates **12** were immersed in acid. Then a mixture of 10% acetylene in nitrogen was introduced into the reactor. Acetylene was decomposed by pyrolysis to form the carbon nanotubes **20** in the template channels (Col 3 lines 15-55). Therefore it would have been obvious to one of ordinary skill in the art to use the nanotube fabrication process of Moskovits et al in the fuel cell fabrication process of Frank et al because Moskovits et al teach that the present method also provides a much more economical method of growing nanotubes since the number of procedural steps is decreased (Col 4 lines 65-67); (Col 5 lines 1-5).

6. Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Frank et al (U.S. Pub. No. 2004/0170884 A1) and Moskovits et al (U.S. Patent No. 6,129,901) as applied to claims 1,2,5, 7, 15-16,19 and 20 above and further in view of Smalley et al (U.S. Pub. No. 2002/0159943 A1).

With respect to claim 8, Frank et al and Moskovits et al disclose a fuel cell system in paragraph 6 above. Frank et al and Moskovits et al do not specifically teach growing boron doped carbon nanotubes on the substrate using a chemical vapor deposition process using acetylene in nitrogen as a carbon source. However, Smalley et al teach a method of forming an array of single-wall carbon nanotubes and compositions thereof wherein while pure carbon nanotubes generally contain side walls that are entirely uniform (consisting of an array of the hexagonal carbon lattice similar

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to that of graphite), it is possible to introduce defects or create bonding sites in the sidewalls to facilitate bonding adhesion to the matrix material. One example would be to incorporate an impurity such as Boron atoms in the side wall (Paragraph 0267).

Therefore it would have been obvious to one of ordinary skill in the art to use the boron doping of Smalley et al in the fuel cell fabrication process of Frank et al and Moskovits et al because Smalley et al teach that it is possible to introduce defects or create bonding sites in the sidewalls to facilitate bonding adhesion to the matrix material (Paragraph 0267).

7. Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Frank et al (DE 101 18 651 A1). See corresponding U.S. Publication - Frank et al (U.S. Pub. No. 2004/0170884 A1) and Dodelet et al (U.S. Pub. No. 2003/0111334 A1) and further in view of De Witt et al. (U.S. Patent No. 3,720,590).

With respect to claim 18, Frank et al disclose a fuel cell wherein the fuel cell has the following characteristics: the electrodes comprise electrically conductive, regularly disposed micro or nanoscale needle-shaped or tubular-shaped electrode elements affixed on a gas-permeable carrier substrate and coated with a catalyst; the electrode elements are fully or partially surrounded on the outside by the material of the electrolytes (See Abstract). Frank et al further teach that specifically, there are two inventive variants of the electrode structure: Electrically conductive, needle-shaped

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electrode elements (hereinafter also referred to as "nanowhiskers") on a carrier substrate, and electrically conductive, tube-shaped electrode elements (hereinafter also referred to as "nanotubes") on a carrier substrate. These electrode elements can also be porous. The electrode elements are coated with a catalyst, and completely or partially surrounded on the outside by the electrolyte material (for example, a polyelectrolyte membrane) (Paragraph 0011 – 0014). Frank et al does not specifically mention growing carbon nanotubes on a carbon substrate using a chemical vapor deposition process. However, Dodelet et al teach a process for preparing carbon nanotubes wherein an object of the present invention is to provide a new carbon vapor deposition method which is capable of producing carbon nanotubes in the absence of amorphous carbon at low heating power (Paragraph 0005). The carbon paper carrying the catalyst is placed between two graphite electrodes, mounted in a quartz tube. In order to obtain the carbon nanotubes, a mixture of 90% argon, 5% hydrogen and 5% of a hydrocarbon gas (acetylene or ethylene) is caused to flow over the paper for 15 minutes (Paragraph 0028). FIG. 2 illustrates a typical area of nanotubes produced on the carbon paper (Paragraph 0030).

Therefore it would have been obvious to one of ordinary skill in the art to use the method of growing of carbon nanotubes on a carbon substrate using a CVD process of Dodelet et al in the fuel cell of Frank et al because Dodelet et al teach that an object of the present invention is to provide a new carbon vapor deposition method which is capable of producing carbon nanotubes in the absence of amorphous carbon at low heating power (Paragraph 0005).

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Frank et al and Dodelet et al do not specifically teach wherein the electrodeposition process comprises electrodepositioning platinum on the nanotubes by three-electrode dc method in 5mM H_2PtCl_6 and 0.5 M H_2SO_4 . However, DeWitt et al. teach a method of coating an electrode wherein The method includes electrodeposition of a layer of a platinum group metal from a solution containing an organic material onto an electroconductive substrate (See Abstract). A plating solution was prepared by mixing 0.78 grams chloroplatinic acid crystals (Reagent A.C.S.), 75 milliliters absolute ethyl alcohol (Reagent Quality), 15 milliliters sulfuric acid (Reagent A.C.S.), 20 milliliters toluene (Certified A.C.S.), and 20 milliliters acetone (Certified A.C.S.) (Col 6 lines 60-67).

Therefore it would have been obvious to use the electrolyte composition of Dewitt et al. to electrodeposit platinum in the nanotubes of Frank et al and Dodelet et al because DeWitt et al teach that the highly-ionizable electrolyte is used for increasing the conductivity of the plating solution and may be any electrolyte that would be compatible with the other materials present and provide the plating solution with the necessary conductivity, for example, an inorganic acid such as sulfuric acid or hydrochloric acid (Col 4 lines 13-20). The compound containing the platinum group metal is a compound that will permit deposition of a platinum metal coating during electrolysis, typically, acids or salts of the metal such as chloroplatinic acid or platinum nitrate (Col 4 lines 45-50).

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8. Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Frank et al (U.S. Pub. No. 2004/0170884 A1), Dodelet et al (U.S. Pub. No. 2003/0111334 A1) and Yates et al. (U.S. Patent No. 6,224,991 B1) as applied to claims 1,2,15-16,19 and 20 above and further in view of Moskovits et al (U.S. Patent No. 6,129,901).

With respect to claim 15, Frank et al disclose a fuel cell in paragraph 2 above. Frank et al does not specifically mention using anodic porous alumina templates to form an aligned array of carbon nanotubes. However, Moskovits et al teach controlled synthesis and metal filling of aligned carbon nanotubes wherein one aspect of the invention there is provided a process for synthesis of carbon nanotube. The method comprises anodizing an aluminum substrate in an effective bath to produce an alumina template with a plurality of pores each having a pore diameter. The method includes depositing an effective catalyst into the pores and exposing the alumina template with the catalyst containing pores to an effective hydrocarbon gas at an effective temperature to grow carbon nanotubes in the pores (Col 2 lines 25-36). The process of synthesizing carbon nanotubes is showed schematically in FIG. 1. Anodic oxidation of an aluminum (99.99%) substrate **10** was carried out. The anodized alumina templates **12** were immersed in acid. Then a mixture of 10% acetylene in nitrogen was introduced into the reactor. Acetylene was decomposed by pyrolysis to form the carbon nanotubes **20** in the template channels (Col 3 lines 15-55). Therefore it would have been obvious to one of ordinary skill in the art to use the nanotube fabrication process of Moskovits et al in the fuel cell fabrication process of Frank et al because Moskovits et al teach that the present method also provides a much more economical method of growing

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nanotubes since the number of procedural steps is decreased (Col 4 lines 65-67); (Col 5 lines 1-5).

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ben Lewis whose telephone number is 571-272-6481. The examiner can normally be reached on 8:30am - 5:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Patrick Ryan can be reached on 571-272-1292. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Ben Lewis

Patent Examiner
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SUPERVISOR OF EXAMINERS